4th DRAFT

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Title: Precision cryogenic dilatometer for James Webb Space Telescope materials testing.

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Abstract:

The James Webb Space Telescope (JWST, formerly NGST, the Next Generation Space Telescope) will be a 6 meter diameter segmented reflector. It will be launched at room temperature, but will be passively cooled to 30 to 60 Kelvin when it reaches its planned location at the L2 point.

Because of the 270 Kelvin drop in temperature after launch, understanding the thermophysical properties of mirror, secondary optics and supporting structures is crucial to the design of an instrument that will provide diffraction limited performance at 2 microns. Once deployed, JWST will perform continuous science for durations ranging from one day to a month, hence an understanding of how small temperature fluctuations will impact the nanometric stability of the optical system through thermal expansion is required.

The JWST materials testing team has designed and built a novel cryogenic dilatometer based on the <100 pm technology previously developed for the Space Interferometry Mission. Samples will be tested in a cryo-cooled vacuum environment with temperature monitored to <10 mK. Our goal is coefficient of thermal expansion (CTE) measurements accurate to 1 ppb/K for copper (for intercomparison with other laboratories) and 0.1 ppb/K for ULE, for a nominal CTE=30 ppb/K. The dilatometer will be used to measure the CTE of samples from JWST primary mirror prototypes, local CTE variations from multiple locations on a prototype mirror, CTE variations from batch to batch of the same material, and thermal and mechanical creep measurements from room temperature down to 15 K.